Discussion of OAQPS Cost Manual Method for AQCS Estimation

The purpose of this document is to explain why the OAQPS Cost Manual is not sufficient for estimating the cost of air quality control (AQC) equipment. This document will first discuss the impact of escalation on the cost of AQC projects. Next, a discussion of the scope items that are missing from the OAQPS cost manual for SCR is included. Finally, a comparison is made between an estimate performed using the OAQPS method and the B&V estimate for PNM San Juan Generating Station (SJGS) BART analysis.

NMED EX. 7j

1.0 Impact of Escalation on AQC Costs

The most recent revision of the OAQPS manual is the EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001, dated January 2002 (the Cost Manual). There have been significant cost increases in AQC equipment since its release. Section 4.2, Chapter 2, Selective Catalytic Reduction, was written in October 2000. In addition to that, on page 2-40, Article 2.4 of the SCR section, it was indicated that the costs presented in the manual are based on 1998 dollars.

In Chapter 2 of the Introduction (Article 2.4.3), the Cost Manual specifically discusses the importance of escalating the cost of equipment to the current year. Costs can and do change dramatically over time. It has been 8 years since the SCR section of the Cost Manual was written, and the reference costs in the Cost Manual are 10 years old. In that time, the AQC industry and the energy industry have seen significant increases in the cost of equipment and construction. The Cost Manual does not take into account the significant increase in demand for equipment, commodities, contractors, and construction labor experienced over the past 9 years from the many retrofits associated with the Acid Rain Program, ozone SIP call, New Source Review (NSR), Prevention of Significant Deterioration (PSD) projects (both new and modifications), the Clean Air Interstate Rule (CAIR) and the BART program, the new coal projects in the US and international markets. Any cost estimate, such as B&V's cost estimate for the BART analysis, must take into account the impact of escalation.

The cost of AQC equipment has increased dramatically over the last few years (2005 to 2007 time frame). Figure 1 is taken from a press release from the Cambridge Energy Research Associates website (the entire press release is included as Reference 1 in Appendix A of this document). This figure shows that between the year 2000 and the year 2007, the refinery industry has seen a 66 percent increase in the cost of implementing large projects. Although this graph is focused on the refinery industry, the electric utility industry uses many of the same vendors, contractors, and raw materials on new power generation projects and AQC projects. As a result, these cost increases are indicative of cost increases being experienced in the electric utility industry.

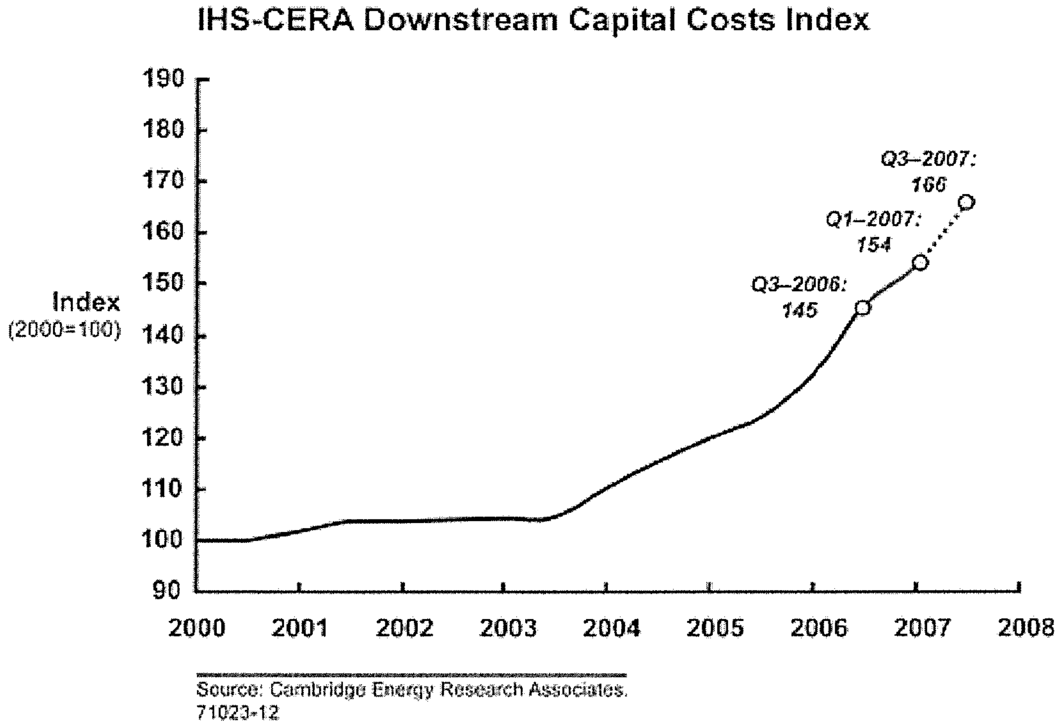

Figure 1

IHS-CERA Capital Cost Index

Another reference that presents the dramatically changing costs associated with AQC projects is a industry paper titled "Current Capital Costs and Cost Effectiveness of Power Plant Emissions Control Technologies" prepared by J. Edward Cichanowicz for the Utility Air Regulatory Group (included as Reference 2 in Appendix A). Mr. Cichanowicz is a well-known utility industry environmental control technology expert who keeps abreast of utility industry environmental control technology trends and costs. He is a former EPRI employee and has produced many publications and presentations for organizations such as Power Engineering magazine and the Electric Utilities Environmental Conference (EUEC). Figure 2 shows a strong example of how the costs of SCR have doubled or tripled since the year 2000. This increase in costs is especially dramatic in the last two years.

The paper describes four "phases" of installation of SCR systems in the US. The first phase is the early SCRs in the US. Phase 2 is the first SCRs installed in response to the OTAG SIP call rules. Phase 3 represents the majority of the SCRs installed in response to the OTAG SIP call. Phase 4 is the current phase. This phase shows very high SCR costs because of the market forces currently impacting the AQC and new generation markets.

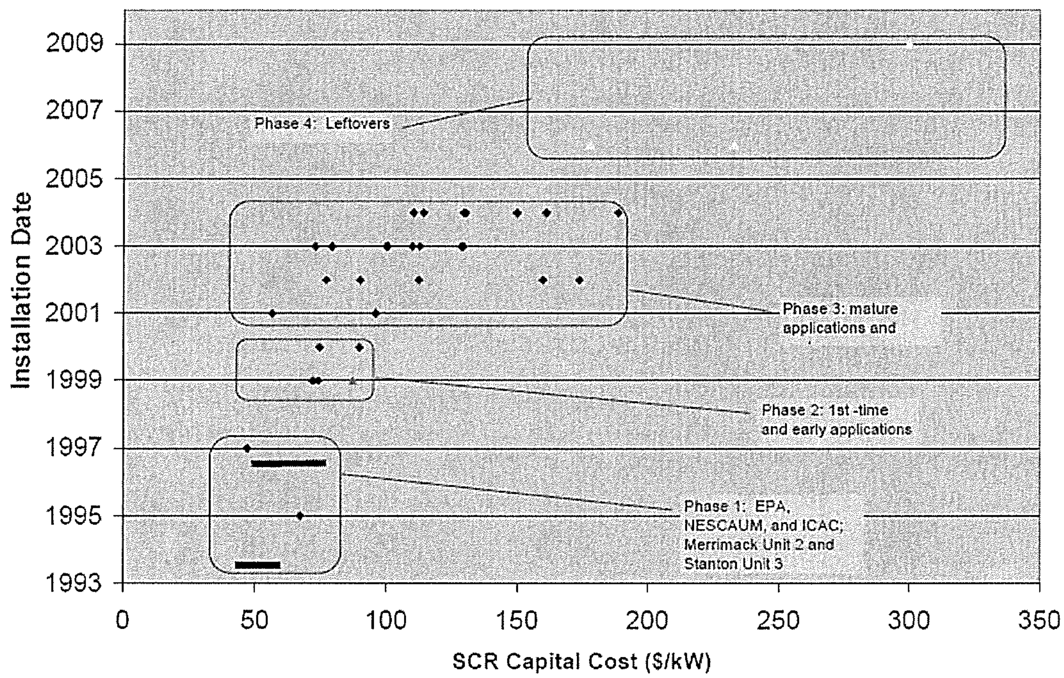

Figure 7-1. Escalation of Cost for SCR Installation with Time

Figure 2

Increases in SCR Costs from Cichanowicz Paper

Figure 3 is data from the U.S. Bureau of Labor Statistics showing the Producer Price Index for metals and metal products. Because SCR systems are comprised mostly of ductwork and structural steel, the increase in price of metal and metal products is a reliable indicator of the price of SCR equipment. It can be seen that the price of metals and metal products has increased by 59 percent between the years 2000 and 2007. It can also be seen that the majority of the escalation has occurred since 2004. This data can be found on Bureau's website at http://www.bls.gov/ppi/home.htm.

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Series Id:   WPU1017
Not Seasonally Adjusted
Group:       Metals and metal products
Item:        Steel mill products
Base Date:   8200
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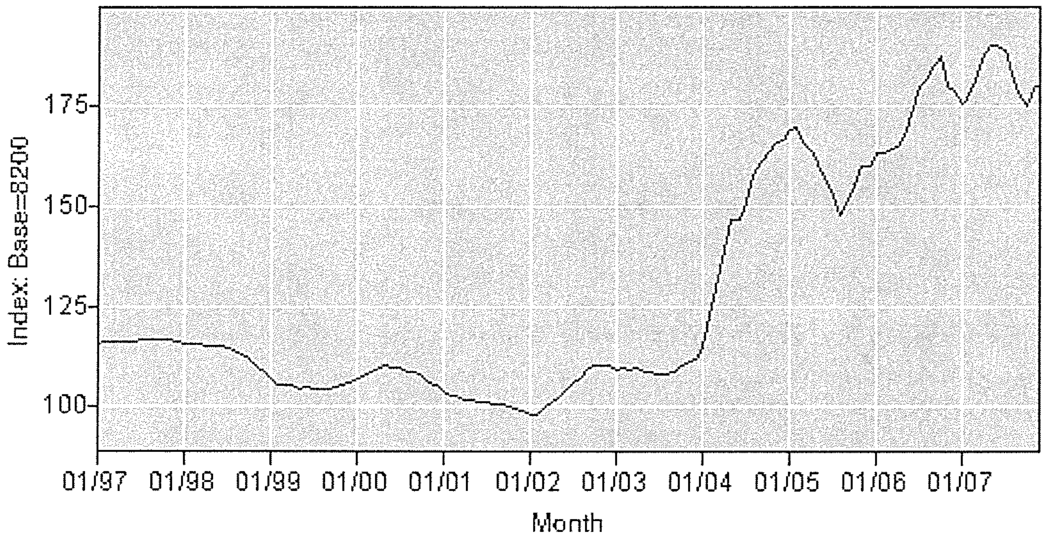

Figure 3

Producer Price Index for Metals and Metal Products

The following quote from a Progress Energy Florida official, Thomas Cornell, is a good description of the price increases that have been experienced by the utility industry: "*the estimated costs of the new air controls have jumped 70% from what was contained in the 2006 filing."There are several reasons for the increase," he explained. "One of the impacts of the final [federal Clean Air Interstate Rule of 2005] was to create significant industry demand for major retrofit construction projects to engineer, procure, and install the necessary air pollution control equipment. This occurred at a time when there was already significant construction activity due, in part, to an improving economy. The situation was exacerbated by even more construction demand in the aftermath of Hurricane Katrina and by the rising demand for steel, concrete and other commodities in countries such as China and India. As a result of these world-wide market conditions, PEF and the industry have seen significant increases in costs for major construction projects, especially for SCR and scrubber equipment and installations. The increases were primarily driven by significant escalation in the cost of basic construction materials* *and in labor costs.*" This quotation is from a June 2007 article in SNLi and can be found at the following website:

http://www.snl.com/InteractiveX/article.aspx?CDID=A-5838501-12640&KPLT=2.

It should also be noted that these cost increases are being experience by the entire industry, not just in the AQC market. New coal generation projects have witnessed significant cost increases over the last few years. A July 2007 article in The New York Times (included in Appendix A as Reference 3) provides the following example: "In late 2004, Duke Energy, one of the country's largest utilities and most experienced builders, started planning a pair of coal-fired power plants... In May 2005, the company told regulators it wanted to spend $2 billion to build twin 800-megawatt units. But 18 months later, in November 2006, Duke said it would cost $3 billion. Then the State Utility Commission said to build only one of the plants, and in May of [2007], Duke said that would cost $1.83 billion, an increase of more than 80 percent from the original estimate."

These aforementioned references agree well with B&V's internal database of costs. Figure 4 presents some of B&V's estimating department's internal indexes for various commodities used in SCR applications and other AQC applications. This data is developed by comparing prices in contracts (with similar scope) obtained in 2005 with those obtained in 2007. As can be seen from this figure, prices on various AQC equipment components have increased dramatically in a very short period of time.

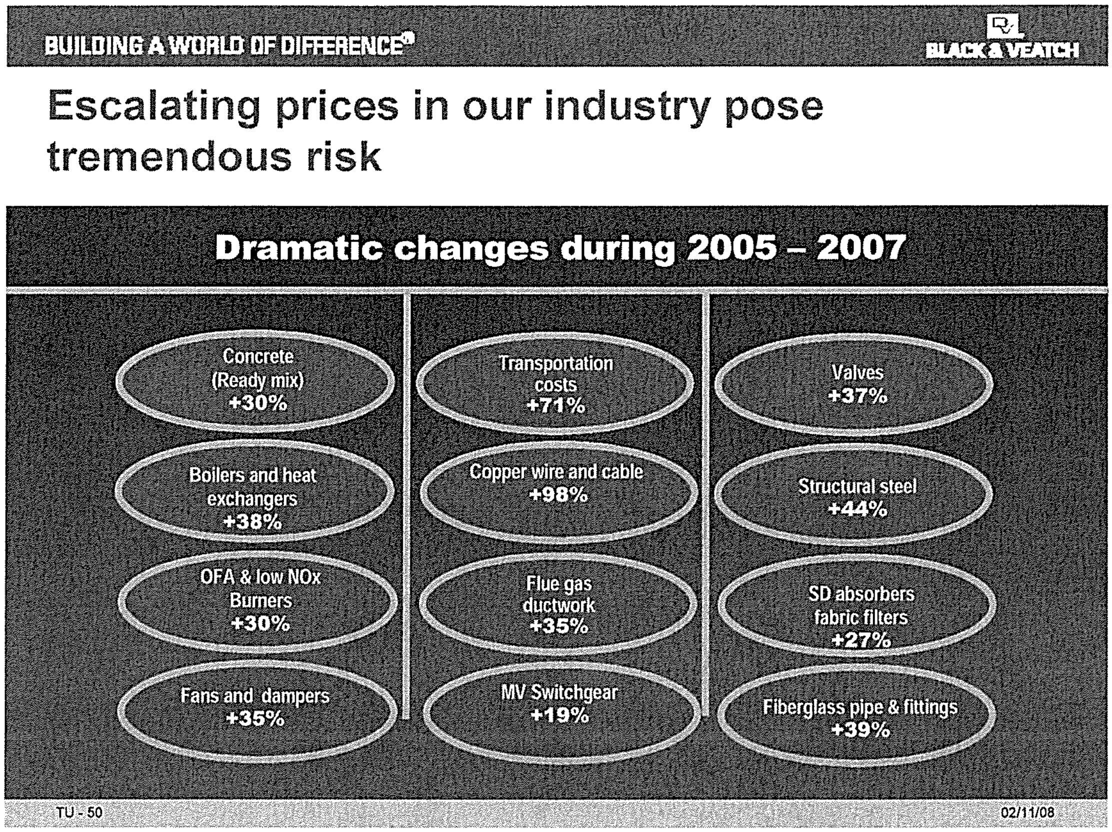

Figure 4

B&V Indexes for AQC-Related Commodities

2.0 Missing Scope in OAQPS Cost Estimate

The Cost Manual presents equations to calculate the components of the SCR system. The Cost Manual has costs factors developed for the following items:

- Reactor ductwork
- Catalyst
- Ammonia system
- SCR bypass
- Retrofit factor
- General factor for all other equipment

It should also be noted that the Cost Manual is geared more towards developing costs for new units than retrofitting controls on existing units. It was originally written to assist utilities with developing costs for BACT analyses.

The SCR cost estimate included in the Cost Manual is missing several key categories of equipment and construction necessary for SCR systems. At the time of the Cost Manual's creation, the industry severely underestimated the balance of plant impacts of SCR. This is evident by the large number of SCR projects built between 2000 and 2004 that had significant cost overruns.

The missing scope items are identified in this section of the document. It should be noted that this section does not discuss how B&V estimated these items. The details of B&V's estimate will discussions in Section 3.0 of this document.

These missing cost items represent real scope and costs that would be borne by PNM if they were required to install SCR on any or all of the units at SJGS. The following discussion supplements an earlier response submitted to the NMED on September 14, 2007.

2.1 Elevator

PNM requires an elevator for maintenance purposes. This would allow the maintenance staff to move more easily equipment such as catalyst tools and NOx monitoring system supplies (such as calibration gas canisters) to the various SCR access platforms. The elevator is not included in the OAQPS estimate.

2.2 SCR Bypass

Although the OAQPS manual includes a cost factor for SCR bypass, it is not accurate or sufficient for all the costs associated with an SCR bypass. For SJGS, the cost of factor results in a cost of approximately $730,000. This cost does not pay for the cost of more than one damper, let alone the ductwork required for the SCR bypass. The SCR bypass dampers are not itemized in the Cost Manual. As previously stated, the SJGS units start up on fuel oil. As a result, there is a great potential for unburned fuel and unburned hydrocarbons to deposit on the catalyst during startup. Because SCR catalyst is an oxidizing catalyst, unburned fuel and unburned hydrocarbons pose a great risk for fires inside the catalyst. It is recommended that the SCR be bypassed during startup operations.

2.3 NOx Monitoring System

The NOx monitoring system is required to measure NOx before and after the catalyst and is an essential part of the SCR system. The measurement is used to control the ammonia feed to the SCR.

2.4 Electrical Upgrades

Upgrades are required to the electrical systems to incorporate the new SCR equipment into the existing system. The scope of electrical upgrades included additional motor control centers (MCC), variable frequency drives (VFD) controls upgrade and substations.

2.5 Instrumentation and Control System

The SCR for this project would need to be incorporated into the existing distributed control system (DCS). This is a typical requirement for an SCR system retrofit but would not be needed for a new unit SCR because the SCR would simply be included in the new DCS.

2.6 Gross Receipt Tax

B&V takes guidance from EPA's CUECost program in developing the costs of SCR systems. The CUECost program includes gross receipt tax as a standard line item in the cost estimate.

2.7 Freight

B&V takes guidance from EPA's CUECost program in developing the costs of SCR systems. The CUECost program includes freight as a standard line item in the cost estimate.

2.8 Air Preheater Modifications

The air heater needs to be modified to make it resistant to ammonium bisulfate (ABS) corrosion and plugging. Ammonium bisulfate is formed from the reaction between sulfur trioxide in the flue gas and ammonia slip from the SCR process. ABS is a sticky, highly corrosive substance that will condense on the "cold end" air heater baskets. The modifications to the air heater include installing new, enamel-coated baskets in the air heater and installing multi-media soot blowers. This will help to minimize plugging from ammonium bisulfate and make the air heater easier to clean. The multi-media soot blowers are used to clean the air heater. The soot blowers use air or steam during plant operation and water during outages to wash off accumulated ammonium bisulfate.

2.9 Balanced Draft Conversion

As previously discussed in PNM's September 14, 2007 submittal, a balanced draft conversion is required for the SJGS. If the SCR is added, the "zero pressure point" of the draft system would move into the region within the boiler. A balanced draft conversion will include stiffening of the boiler and modification to the fans of the draft system.

2.10 Site Preparation

As previously stated in PNM's September 14, 2007 submittal, site preparation is a lump-sum estimate for required site work such as modifying underground facilities, moving buildings, etc.

2.11 Buildings and Enclosures

An enclosure is required around the ammonia storage system for safety and ammonia containment.

2.12 Engineering

B&V takes guidance from EPA's CUECost program in developing the costs of SCR systems. The CUECost program provides a more accurate method for calculating the cost for engineering services than does the OAQPS Cost Manual.

2.13 Contingency

B&V takes guidance from EPA's CUECost program in developing the costs of SCR systems. The CUECost program allows contingency costs to be calculated as 20 percent of the direct capital costs. B&V used this method of calculating contingency instead of the OAQPS method of using 15 percent.

2.14 Owner Costs

PNM would incur a significant amount of costs to install an SCR system. Owner's costs include items such as staff for site coordination during construction, equipment receiving, contract management, interface with regulatory agencies, and owner engineering costs.

2.15 Construction Management

This item is applicable to both new units and retrofit units. However, with new units, the costs for construction management are difficult to identify because the AQC systems are a portion of the overall project. However, on an AQC retrofit project, all construction management expenses are attributed specifically to the AQC retrofit. Construction management costs include the cost for engineering support, construction oversight by PNM or their engineer, environmental services, secretarial services, safety personnel, quality assurance personnel, drug testing, and other services required to ensure that the construction is performed in accordance with the scope of work, safe work practices, regulatory requirements, construction instructions, construction drawings, and vendor requirements.

2.16 Construction Indirects

Cost items included in construction indirects include construction equipment, construction contractor overhead and profit, tools, site trailers and utilities, construction supervision, and construction contractor administrative support. The Cost Manual does not address these costs in any way yet these are real costs that will be incurred in order to support the direct cost of installing the SCR system.

2.17 Startup and Spare Parts

This item includes costs for startup such as development of startup procedures, pre-startup safety review, startup equipment, startup operators, field technical services from vendors, and operations and maintenance training. Spare parts are also included in this category.

2.18 Performance Test

The performance testing is done to demonstrate compliance with permits and to demonstrate that contractual guarantees have been met.

3.0 Comparison of B&V Cost Estimate to Cost Manual Estimate

In NMED's December 21, 2007 letter to PNM, the NMED requested that the cost estimate for SCR be performed using the OAQPS Cost Manual. Sections 1.0 and 2.0 of this document were written to explain why B&V did not use the Cost Manual to prepare the estimate for the SJGS BART analysis. As previously stated, there are two main reasons that the Cost Manual was not used. First, the price of SCR systems (and other AQC retrofits) has increased dramatically in the past 10 years, and especially since 2005. Second, the Cost Manual does not include many categories of equipment and construction that are required for the complete installation of an SCR system consistent with common industry practices. While it was representative of industry knowledge of SCR systems in October 2000, the Cost Manual no longer provides an accurate estimate of the actual cost of SCR. Therefore, B&V developed a cost estimate for the SJGS BART analysis based on an internal database of costs for recent SCR projects. Where possible, B&V scaled the costs from actual vendor quotations from another representative project.

However, in order to respond to NMED's request, B&V has performed a cost estimate using the Cost Manual for SJGS Unit 3. Figure 5 shows the results of that analysis. In this analysis, B&V did not add any of the necessary scope items that are missing from the Cost Manual program as described in Section 2.0 to the estimate. However, in accordance with Chapter 2 of Introduction, B&V did escalate the costs developed from Cost Manual to 2007 dollars. We used the CERA cost index shown in Figure 1 of this document. After incorporating the escalation, we then compared the Cost Manual estimate to B&V's estimate ***<u>FOR A SIMILAR SCOPE</u>***. The results show that B&V's estimate is very similar and on the same scale to the estimate developed from the Cost Manual.

Cost Parameter	Variable Name	Multiplier	Equation	(1998 $) Cost Amount	Escallation to 2007	B&V Estimate	Comments
Total Direct Capital Costs	**A**		**DCC**	**22,327,000**	**37,063,000**	**38,345,000**	
Indirect Installation Costs							
General facilities		0.05	A	1,116,000	1,853,000	1,917,000	
Engineering and home office fees		0.1	A	2,233,000	3,706,000	2,684,000	B&V used 7%
Process contingency		0.05	A	1,116,000	1,853,000	1,917,000	
Total Indirect Installation Costs	**B**		**0.05A + 0.10A + 0.05A**	**4,465,000**	**7,412,000**	**6,518,000**	
Project Contingency	C	0.15	(A+B)	4,018,800	6,671,000	8,973,000	B&V used 20%
Total Plant Costs	D		A + B + C	30,811,000	51,146,000	53,836,000	
Allowance for Funds During Construction	E		=0 (for SCR - OAQPS)	0	0	0	
Royalty Allowance	**F**		=0 (for SCR - OAQPS)	0	0	0	
Preproduction Cost	G	0.02	(D+E)	616,000	1,023,000	1,077,000	
Inventory Capital	H		ICC	129,000	129,000	129,000	
Initial Catalyst and Chemical	I		=0 (for SCR - OAQPS)	0	0	0	
Total Capital Investment	**TCI**		**D + E + F + G + H + I**	**31,556,000**	**52,298,000**	**55,042,000**	

For Similar Scope, the Cost Manual Estimate and B&V's Estimate are very similar

Figure 5

SJGS Unit 3 - Comparison of Cost Manual Estimate to B&V Estimate

Not Including the Necessary Scope Missing from Cost Manual

However, the estimate shown in Figure 5 is not correct. It does not include cost items that are necessary and appropriate to install an SCR system. This estimate does not represent the true costs that would be borne by PNM if they were required to install SCRs at SJGS. It is unacceptable for the NMED to base regulatory decisions on inaccurate costs if those decisions would require PNM to spend a large amount of capital in retrofitting AQC equipment to their unit. Additionally, if an inaccurate cost estimate were to be the basis of a regulatory determination, NMED would not be responsible for the cost overruns and additional incurred project costs, these would fall on PNM. The cost items missing from the Cost Manual are described in detail in Section 2.0 of this document. If these cost items are added to the estimate, the results are shown in Figure 6. The red boxes identify the missing cost items. As can be seen, when the estimate developed using the Cost Manual is adjusted to reflect the true scope of work necessary for installing SCR, the Cost Manual estimate is very similar to B&V's estimate. Since the methodologies in cost development for all the SJGS units are similar, the same conclusion on the accuracy and completeness of a cost estimate based on the Cost Manual will be applicable to the other SJGS units.

Calculation of Capital Investment - OAQPS Method (Adjustment for Missing Scope)

Cost Parameter	Variable Name	Multiplier	Equation	Cost Amount	Escallation to 2007	B&V Estimate	Comments
Equipment Costs	EC					18,331,000	See original est
Installation Costs	IC					20,806,000	See original est
Total Direct Capital Costs from OAQPS	A		DCC	22,327,000	37,062,820	39,137,000	
Additions for Missing Scope on Direct Installation Costs							
Elevator	J		B&V Estimate Used		1,236,000	1,236,000	
SCR Bypass	K		B&V Estimate Used		10,000,000	10,000,000	
Nox Monitoring System	L		B&V Estimate Used		440,000	440,000	
Electrical Upgrades	M		B&V Estimate Used		484,000	484,000	
Instrumentation and Control System	N		B&V Estimate Used		291,000	291,000	
Subtotal of Missing Direct Capital Cost	CC		J+K+L+M+N		12,451,000	12,451,000	
Gross Receipt Tax	GRT	0.062	0.062 * (EC + CC)		1,848,000	1,908,000	From CUECost
Freight	FR	0.05	0.05 * (EC + CC)		1,491,000	1,539,000	From CUECost
Installation Costs on Missing Scope	IMS	1.135	1.135*(CC+GRT+FR)		17,922,000	18,044,000	
Air Preheater Modifications	Q		B&V Estimate Used		8,685,000	8,685,000	
Balanced Draft Conversion	R		B&V Estimate Used		17,122,000	17,122,000	
Site Preparation	S		B&V Estimate Used		2,000,000	2,000,000	
Buildings & Enclosures	T		B&V Estimate Used		500,000	500,000	
Total Cost of Missing Scope	MS		CC+IMS+GRT+FR+Q+R+S+T		62,019,000	62,249,000	
Total Direct Capital Costs with Adjustments	DCCA		DCC+MS		99,081,820	101,386,000	
Indirect Installation Costs							
General facilities		0.05	A		1,853,000	0	
Engineering and home office fees		0.1	A		3,706,000	0	
Engineering (B&V Calculation)		0.07	DCCA		0	7,097,000	CUECost method
Process contingency		0.05	A		1,853,000	0	
Total Indirect Installation Costs from OAQPS	B		0.05A + 0.10A + 0.05A		7,412,000	7,097,000	
Project Contingency	C	0.15	(A+CC+B)		8,539,000	0	
Project Contingency (B&V Calculation)	CBV	0.2	DCCA		0	20,277,000	CUECost method
Total Plant Costs	D		A+B+C		53,014,000	66,511,000	
Allowance for Funds During Construction	E		=0 (for SCR - OAQPS)		0	0	
Royalty Allowance	F		=0 (for SCR - OAQPS)		0	0	
Preproduction Cost	G	0.02	(D+E)		1,060,000	0	
Inventory Capital	H		ICC		0	0	
Initial Catalyst and Chemical	I		=0 (for SCR - OAQPS)		0	0	
Total Capital Investment	TCI		D + E + F + G + H + I		54,074,000	66,511,000	
Additions for Missing Scope on Indirect Costs							
Owner's Costs	OC	0.05	DCCA		4,954,000	5,069,000	
Construction Management	CM	0.10	DCCA		9,908,000	10,139,000	
Construction Indirects	CI		B&V Estimate		25,498,000	25,498,000	
Start-up and spare parts	SU	0.03	DCCA		2,972,000	3,042,000	
Performance Test	PT		B&V Estimate		200,000	200,000	
Total Cost of Missing Indirect Costs Scope	MICS		OC+CM+CI+SU+PT		43,532,000	43,948,000	
Subtotal of Indirect Costs	IC		B+C+E+F+G+H+MICS		60,543,000	71,322,000	
Interest During Construction	IDC	0.0741	See Note Below		$17,742,000	$19,196,000	CUECost Allows
Lost Generation During Outage	GEN		5 weeks @ 0.06095 $/kWh		23,674,000	23,674,000	
Total Capital Investment with Adjustments	TCIA		DCCA + IC+IDC+GEN		201,040,820	215,578,000	

OAQPS Results and B&V Results are comparable

Figure 6

SJGS Unit 3 - Comparison of Cost Manual Estimate to B&V Estimate Including the Necessary Scope Missing from Cost Manual

4.0 Explanation of B&V Cost Development

NMED's December 21, 2007 letter requests more information on the development of B&V's cost estimate. B&V used a scaled-factor estimate approach when developing the SCR cost estimate. A scaling factor is used in this type of high-level cost estimate by referencing equipment cost from a similar scope SCR project to that at SJGS. In this section, a detailed description on the development of how each equipment cost line item was calculated.

In Appendix C, B&V has included many of the quotations that were used as references for the estimate. Normally, this is not something that B&V is able to do because the quotations are confidential. However, many of the quotations used to develop the SJGS cost estimate were firm bids taken from another project that was performed for a municipality ("reference SCR"). As a result, the project had public bid openings and the proposals are considered public record. It should be noted that some of the identifying information has been redacted to make this information somewhat more difficult for our competitors (and our client's competitors) to easily track. During the development of the SJGS-specific SCR cost based on this reference, the reference SCR project was still in the contract award stage. Several of the equipment cost line items were based on budgetary estimates for the reference SCR project. Since then, firm quote have been obtained for the reference SCR project. While, the numerical value between the firm quotes and budgetary values used in the development of the SJGS SCR have changed slightly, it should be noted that the magnitude of costs are still very similar. B&V's estimate also uses the EPA CUECost program as a guide for some of the costs included in our estimate. B&V has noted in Figure 6 all areas where we use the CUECost method for calculating costs.

As previously stated, the SCR cost estimate prepared for PNM SJGS Unit 3 was based on firm bids from another recent SCR project (currently being built and scheduled to start operating in July 2008). Scaling factors were used to correlate the reference cost to an estimated value if SCR were to be installed at PNM SJGS Unit 3. The type of scaling factor utilized is dependent on the equipment that is being evaluated. Type of scaling factors used includes:

- Unit size (MW).
- NOx removal rate (lb/mmBtu).
- Gas flow rate.

The scaling factors are used in conjunction with a retrofit factor, typically an exponential of 0.6. This retrofit factor accounts for the non-linear relationship between costs and unit size.

Lastly, for several equipment line items, a complexity factor was applied account for the retrofit complexity of PNM SJGS Unit 3. The retrofit complexity was applied on equipment cost line items where cost is very dependent on the retrofit efforts. Generally, if it is expected that it is more complex to retrofit in the SCR components, greater costs should be allocated for it. Such cost categories for the SCR project are; SCR bypass and structural steel.

A summary of the calculation methods and references used are described in the detail in the following subsections.

4.1 Anhydrous Ammonia Injection System

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= $758,546 (see quotation in Appendix C)
Reference unit size	= 670 MW
PNM unit size	= 544 MW
Reference NOx removal	= 0.34 lb/mmBtu
PNM NOx removal	= 0.30 lb/mmBtu – 0.07 lb/mmBtu = 0.23 lb/mmBtu

Calculation:

$$PNM\ cost = escalation\_rate \times reference\_cost \times \left[\left(\frac{PNM\_unit\_size}{ref\_unit\_size}\right)\left(\frac{PNM\_NOx\_removal}{ref\_NOx\_removal}\right)\right]^{0.6}$$

$$PNM\ cost = 1.03 \times \$758{,}546 \times \left[\left(\frac{544}{670}\right)\left(\frac{0.23}{0.34}\right)\right]^{0.6}$$

$$PNM\ cost = \underline{\underline{\$559{,}000}}$$

Notes/Remarks:

Reference cost was based on the total of the unit price breakdown as detailed in Appendix C. Note that final contract award value was $2,945,000 for 2 units ($1,472,500 per unit) for all equipment scope (including common equipment) detailed in Section 4.1 and 4.2.

4.2 Anhydrous Ammonia Vaporization System

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= \$757,808 (see quotation in Appendix C)
Reference unit size	= 670 MW
PNM unit size	= 544 MW
Reference NOx removal	= 0.34 lb/mmBtu
PNM NOx removal	= 0.30 lb/mmBtu – 0.07 lb/mmBtu = 0.23 lb/mmBtu

Calculation:

$$PNM\ \mathrm{cost} = escalation\_rate \times reference\_\mathrm{cost} \times \left[\left(\frac{PNM\_unit\_size}{ref\_unit\_size}\right)\left(\frac{PNM\_NOx\_removal}{ref\_NOx\_removal}\right)\right]^{0.6}$$

$$PNM\ \mathrm{cost} = 1.03 \times \$757{,}808 \times \left[\left(\frac{544}{670}\right)\left(\frac{0.23}{0.34}\right)\right]^{0.6}$$

$$PNM\ \mathrm{cost} = \underline{\underline{\$559{,}000}}$$

Notes/Remarks:

Reference cost was based on the total of the unit price breakdown as detailed in Appendix C. Note that final contract award value was \$2,945,000 for 2 units (\$1,472,500 per unit) for all equipment scope (including common equipment) detailed in Section 4.1 and 4.2.

4.3 Reactor Box, Breeching and Ductwork

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= \$5,448,557 (see quotation in Appendix C)
Reference gas flow rate	= 3,081,500 acfm
PNM gas flow rate	= 3,082,200 acfm

Calculation:

$$PNM\cos t = escalation\_rate \times reference\_\cos t \times \left(\frac{PNM\_gas\_flow\_rate}{ref\_gas\_flow\_rate}\right)^{0.6}$$

$$PNM\cos t = 1.03 \times \$5{,}448{,}557 \times \left(\frac{3{,}082{,}200}{3{,}081{,}500}\right)^{0.6}$$

$$PNM\cos t = \underline{\underline{\$5{,}613{,}000}}$$

Notes/Remarks:

Reference cost was based on an estimated cost for another project. When the final contract was signed, the price was \$9,754,446 for 2 units (\$4,877,223 per unit).

4.4 Ductwork Expansion Joints

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= \$360,000 (see quotation in Appendix C)
Reference gas flow rate	= 3,081,500 acfm
PNM gas flow rate	= 3,082,200 acfm

Calculation:

$$PNM\cos t = escalation\_rate \times reference\_\cos t \times \left(\frac{PNM\_gas\_flow\_rate}{ref\_gas\_flow\_rate}\right)^{0.6}$$

$$PNM\cos t = 1.03 \times \$360{,}000 \times \left(\frac{3{,}082{,}200}{3{,}081{,}500}\right)^{0.6}$$

$$PNM\cos t = \underline{\underline{\$371{,}000}}$$

4.5 Catalyst

Inputs:

PNM catalyst volume = 496 m^3

Catalyst unit price = \$6,500 per m^3

Calculation:

$$PNM \cos t = PNM\_catalyst\_vol \times catalyst\_unit\_price$$

$$PNM \cos t = 496 \times \$6,500$$

$$PNM \cos t = \underline{\underline{\$3,225,000}}$$

4.6 Sonic Horns

Inputs:

Escalation rate = 1.03 (1 year to 2007)

Reference cost = \$182,040 (see quotation in Appendix C)

Calculation:

$$PNM \cos t = escalation\_rate \times reference\_\cos t$$

$$PNM \cos t = 1.03 \times \$182,040$$

$$PNM \cos t = \underline{\underline{\$188,000}}$$

Notes/Remarks:

Reference cost was based on a preliminary quotation. The final contract award value was \$275,022 for 2 units (\$137,511 per unit).

4.7 Elevator

Inputs:

Escalation rate = 1.03 (1 year to 2007)

Reference cost = $1,200,000 (see quotation in Appendix C)

Calculation:

$$PNM\ \cos t = escalation\_rate \times reference\_\cos t$$
$$PNM\ \cos t = 1.03 \times \$1{,}200{,}000$$
$$PNM\ \cos t = \underline{\underline{\$1{,}236{,}000}}$$

Notes/Remarks:

Reference cost was based on a preliminary quotation. Contract award price was $957,940.

4.8 SCR Bypass

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= $5,346,050 (see quotation in Appendix C)
Reference gas flow rate	= 3,081,500 acfm
PNM gas flow rate	= 3,082,200 acfm
Retrofit complexity factor	= 1.8

Calculation:

$$PNM\ \mathrm{cost} = escalation\_rate \times reference\_\mathrm{cost} \times \left(\frac{PNM\_gas\_flow\_rate}{ref\_gas\_flow\_rate} \right)^{0.6} \times complexity\_factor$$

$$PNM\ \mathrm{cost} = 1.03 \times \$5{,}346{,}050 \times \left(\frac{3{,}082{,}200}{3{,}081{,}500} \right)^{0.6} \times 1.8$$

$$PNM\ \mathrm{cost} = \underline{\underline{\$10{,}000{,}000}}$$

Notes/Remarks:

The complexity factor used here accounts for the following items needed to complete the SCR bypass: seal air ductwork, damper access platforms, SCR bypass ductwork, SCR bypass support steel, and expansion joints.

4.9 Structural Steel

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= $5,732,120 (see details in Appendix C)
Reference unit size	= 670 MW
PNM unit size	= 544 MW
Retrofit complexity factor	= 1.5

Calculation:

$$PNM\ \cos t = escalation\_rate \times reference\_\cos t \times \left(\frac{PNM\_unit\_size}{ref\_unit\_size}\right)^{0.6} \times complexity\_factor$$

$$PNM\ \cos t = 1.03 \times \$5{,}732{,}120 \times \left(\frac{544}{670}\right)^{0.6} \times 1.5$$

$$PNM\ \cos t = \underline{\underline{\$7{,}816{,}000}}$$

Notes/Remarks:

Reference cost was based on budgetary estimates of structural steel requirements and commodity prices for structural steel as detailed in Appendix C. The final contract award value was $14,074,040 for 2 units ($7,037,020 per unit).

The retrofit complexity factor used here accounts for the restrictions in the plant layout, the available laydown area, and the potential crane size allowable at SJGS.

4.10 NOx Monitoring System

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= \$427,200 (see quotation in Appendix C)

Calculation:

$$PNM\ cost = escalation\_rate \times reference\_cost$$

$$PNM\ cost = 1.03 \times \$427{,}200$$

$$PNM\ cost = \underline{\underline{\$440{,}000}}$$

Notes/Remarks:

Reference cost was based on a preliminary quotation. Final awarded contract was \$779,450. The final price also included sampling fans at a price of \$17,555 for 2 units.

4.11 Electrical System Upgrade

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= \$532,550 (see quotation in Appendix C)
Reference unit size	= 670 MW
PNM unit size	= 544 MW

Calculation:

$$PNM\ cost = escalation\_rate \times reference\_cost \times \left(\frac{PNM\_unit\_size}{ref\_unit\_size}\right)^{0.6}$$

$$PNM\ cost = 1.03 \times \$532{,}550 \times \left(\frac{544}{670}\right)^{0.6}$$

$$PNM\ cost = \underline{\underline{\$484{,}000}}$$

Notes/Remarks:

Reference cost was based on a preliminary quotation. Final awarded contract cost was based on quotations for multiple scope items totaling to \$1,431,788 for 2 units (\$715,894 per unit) as detailed in Appendix C.

4.12 Instrumentation and Control System

Inputs:

Escalation rate	= 1.03 (1 year to 2007)
Reference cost	= $288,000 (see quotation in Appendix C)
Reference unit size	= 670 MW
PNM unit size	= 544 MW

Calculation:

$$PNM\cos t = escalation\_rate \times reference\_\cos t \times \left(\frac{PNM\_unit\_size}{ref\_unit\_size}\right)^{0.1}$$

$$PNM\cos t = 1.03 \times \$288{,}000 \times \left(\frac{544}{670}\right)^{0.6}$$

$$PNM\cos t = \underline{\underline{\$291{,}000}}$$

Notes/Remarks:

Reference cost was based on a preliminary quotation. Final awarded contract cost was based on quotations for multiple scope items totaling to $1,008,761 for 2 units ($504,381 per unit) as detailed in Appendix C.

4.13 Air Preheater Modifications

For Units 3 or 4, enamel coated, air preheater basket replacement is recommended if an SCR or SNCR is installed. Air preheater modifications for Units 1 or 2 would also be required, but the scope of work will be different since the air preheater type is different than that at Units 3 or 4. Material costs for air preheater modifications were obtained from a budgetary quotation solicited from an air preheater original equipment manufacturer (OEM) specifically for the PNM project. A comparison to a previous project for a confidential client was made to determine the installation price.

The total direct cost is the summation of the material and installation costs. There are one primary air preheater and two secondary preheaters in Unit 3.

		2007 400MW Confidential ($ USD)	2007 544 MW PNM Units 3&4 ($USD)	Reference
PRIMARY	material per unit	n/a	$533,000	Vendor quote
	Installation per unit	$707,000	$961,966	
SECONDARY	material per unit	n/a	$1,030,000	Vendor quote
	Installation per unit	$1,886,000	$2,565,242	
Total materials per unit			$2,593,000	
Total installation per unit			$6,092,000	
Total per unit			$8,685,000	
Notes: 1. Costs exclude contingency and indirects.				

4.14 Balanced Draft Conversion

The attached table shows a breakdown of the cost estimate for a balanced draft conversion of the PNM SJGS Unit 3 system, required if an SCR were installed. The cost estimate was developed based on reference to the project cost of other reference units where B&V performed a balanced draft conversion. A scaling and retrofit factor was used to determine the engineering & material and construction labor costs.

The total direct cost is the summation of the engineering and material, and construction labor costs.

	Reference Unit		PNM Unit 3 or 4	
Balanced Draft Conversion	Engineering & Material	Construction Labor Costs	Engineering & Material	Construction Labor Costs
Boiler				
Stiffening	$1,800,000	$2,545,000	$1,537,000	$1,908,000
Scaffolding	- -	$350,000	- -	$262,000
Insulation & Lagging	$250,000	$1,250,000	$188,000	$1,438,000
Ductwork & Casing Repairs (Allowance)	$545,000	$3,025,000	$182,000	$1,009,000
Air Heater				
Stiffening	$150,000	$350,000	$125,000	$263,000
Electrostatic Precipitator				
Stiffening (Excludes casing repairs)	$512,000	$2,000,000	$416,000	$1,500,000
Insulation & Lagging (Allowance)	$150,000	$750,000	$113,000	$563,000
Electrical/Control Modifications	$285,000	$600,000	$214,000	$450,000
New transformer (subcontract)			$1,000,000	
Fan Modifications				
FD Fans (new motors only)	$440,000	$154,000	$660,000	$116,000
ID Fans	$5,410,000	$1,577,000	$3,600,000	$1,260,000
Miscellaneous Mech Commodities and Inst	$325,000	- -	$325,000	- -
Subtotal			$8,357,000	$8,765,000

Notes:
1. Costs exclude contingency and indirects.

4.15 Construction Indirects

The construction indirects line item was developed based on the total labor costs for the installation of the SCR equipment. In pre-2004, B&V's estimating department found that the total amount of construction indirect costs typically ranged from 50 percent to 60 percent of the total installation labor costs. However, due to the tightening in labor market that has developed since 2005, construction indirect costs have risen to a range of 90 percent to 120 percent. For the cost estimate of an SCR at PNM SJGS Unit 3, it was determined by B&V's estimating department that a construction indirect rate of 100 percent of total installation labor cost best represented the labor market situation. The table below shows B&V's calculation of construction indirects.

		Direct Installation Cost Splits			
Scope of installation	Direct installation costs	Material	Labor	Material	Labor
Foundation & supports	$10,268,000	70%	30%	$7,187,600	$3,080,400
Handling & erection	$13,690,000	0%	100%	$0	$13,690,000
Electrical	$5,134,000	40%	60%	$2,053,600	$3,080,400
Piping	$856,000	40%	60%	$342,400	$513,600
Insulation	$3,423,000			$0	$0
Painting	$342,000			$0	$0
Demolition	$3,423,000	0%	100%	$0	$3,423,000
Relocation	$1,711,000	0%	100%	$0	$1,711,000
Total	$38,847,000				$25,498,400

Construction Indirects = Direct Installation Labor X 100%

= $25,498,400

5.0 Conclusions

This document shows that simply using the OAQPS Cost Manual to develop an estimate for SCR equipment does not result in an accurate estimate of the cost of the SCR. First, the costs in the manual are in 1998 dollars and must be escalated to 2007 dollars. In addition, there were very few SCR's installed in the United States in 1998 and very little industry experience regarding all of the work required to install an SCR system. As a result, the Cost Manual does not include cost items in its scope that are required to install an SCR system. For these reasons, B&V developed a cost estimate based on the experience from previous SCR projects that have been implemented by B&V. Quotations from vendors were used for the cost estimates, where possible, and with B&V's internal estimating methods in other cases.

It should be noted that B&V's estimate is in line with industry information and represents current costs of SCR systems. Consider Reference 2, the paper written by Mr. Cichanowicz and discussed in Section 1.0 of this document. It indicates that the current cost of SCR is between \$180 / kW and \$300 / kW, where kW references the size of the unit. Most units do not require a balance draft conversion but SJGS would require a balanced draft conversion for each unit. For comparison purposes, if the balance draft conversion cost were to be removed from the cost estimate of the SCRs for SJGS, the cost of the SCR for Unit 3 would be \$164,309,000. This is equivalent to \$243 / kW. This is exactly in the range of costs for SCRs that are currently being built. It shows again that B&V's costs are representative of the industry at this time. It also further proves that the Cost Manual is not an accurate representation of the costs for an SCR project, without appropriate escalation and adjustments for additional equipment and cost items. As stated before, selection of BART for a unit MUST be based on an evaluation of the real costs for a project, not on the inaccurately low cost estimate developed from the Cost Manual.

APPENDICES A – C

OF NMED Ex. 7j

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